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[54] Title of the Invention: Planar Heating Unit and Heating Apparatus Using the Same

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[57] Abstract

[Object] To prevent electrodes and heating element from being damaged even when subjected to expansion and flexion.

[Means to Solve the Problem] A flexible planar heating unit comprises electrodes 1a and 1b made of an electrically conductive material, and heating element 2 having a self-temperature regulating function and electrically connected with electrodes 1a and 1b, wherein any of the electrodes 1a, 1b and heating element 2 is mixed with a material of flexibility.

[What is claimed is]

[Claim 1] A planar heating unit comprising an electrode, and a heating element having a self-temperature regulating function and electrically connected with the electrode, wherein a part of the electrode and the heating element is mixed with a material of flexibility.

[Claim 2] The planar heating unit as set forth in claim 1, wherein the material of flexibility comprises at least one of an urethane resin and a polyester resin.

[Claim 3] The planar heating unit as set forth in one of claim 1 and claim 2, wherein the electrode and the heating element are disposed on at least a part of a substrate having flexibility.

[Claim 4] The planar heating unit as set forth in claim 3, wherein the substrate having flexibility comprises any of fabric, leather and rubber.

[Claim 5] The planar heating unit as set forth in one of claim 1 through claim 4, wherein at least a part of the electrode and the heating element comprises a conductive film.

[Claim 6] The planar heating unit as set forth in claim 5, wherein the conductive film is formed by a printing method.

[Claim 7] The planar heating unit as set forth in one of claim 5 and claim 6, wherein the conductor film constituting the electrode has a thickness between 5 and 40μm.

[Claim 8] The planar heating unit as set forth in one of claim 5 through claim 7, wherein the conductor film constituting the heating element has a thickness between 10 and 100μm.

[Claim 9] The planar heating unit as set forth in one of claim 1 through claim 8, wherein at least a part of the electrode and the conductor film has flexibility.

[Claim 10] A heating apparatus provided with the planar heating unit as set forth in one of claim 1 through claim 9.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to a planar heating unit used for a planar heating/warming apparatus having a self-temperature regulating function such as a floor heater, an electrically-heated carpet, a tatami-mat heater, an automobile seat heater and the like, and also a planar heating unit used for a water heater, a rice cooker and the like.

[0002]

[Background Art] A planar heating unit of the prior art is shown in Fig. 5. Reference mark 107 denotes a substrate having an electrically insulating property. A pair of bus electrodes 101a and 101b having electrical conductivity, and branch electrodes 106a and 106b branching off from the pair of bus electrodes 101a and 101b are formed on substrate 107. Branch electrodes 106a branching off from bus electrode 101a and branch electrodes 106b branching off from bus electrode 101b are formed in a pattern of interdigitating with one another at regular intervals. Reference mark 102 denotes a heating element formed over branch electrodes 106a and 106b. Heating element 102 has a self-temperature regulating function, and is connected electrically with branch electrodes 106a and 106b. Reference mark 103 denotes a power supply, and reference marks 105a and 105b denote connecting wires for connecting power supply 103 to bus electrodes 101a and 101b. Reference marks 104a and 104b are connectors, each connecting between respective connecting wires 105a, 105b, and bus electrodes 101a, 101b. Connectors 104a and 104b comprise rivets, which connect eyelet terminals crimped at the ends of connecting wires 105a and 105b to bus electrodes 101a and 101b.

[0003] In the above structure, a voltage supplied from power supply 103 produces a difference in electric potential between branch electrodes 106a and 106b, and this electric potential causes an electric current to flow and to

generate heat in heating element 102. This heating element 102 provided with the self-temperature regulating function has such a characteristic that its temperature rises when energized, but its resistance increases rapidly when it reaches a given temperature, thereby regulating its own temperature.

[0004]

[Problems to be Solved by the Invention] In the above-described planar heating unit of the prior art, however, it was a common practice that electrodes composed of conductive films and a heating element having a self-temperature regulating function are formed by such a method as screen printing on an inflexible substrate such as a mirror. The conventional planar heating units were therefore not adaptable for products that require flexibility such as floor heaters, electrically-heated carpets, tatami-mat heaters, automobile seat heaters and the like, because of the lack of flexibility.

[0005] Even when the substrates are made of woven fabrics having extensibility and flexibility or polyester films having a certain extent of flexibility, the heating units are not adaptable for use in floor heaters, electrically-heated carpets, tatami-mat heaters, automobile seat heaters and the like, since the electrodes and the heating elements will be damaged due to flexing because of their lack of flexibility.

[0006]

[Means to Solve the Problems] To solve the above problems of the prior art, a planar heating unit of the present invention comprises an electrode, and a heating element having a self-temperature regulating function and electrically connected with the electrode, wherein a part of the electrode and the heating element is mixed with a material of flexibility.

[0007] According to the present invention, at least a part of the electrode and the heating element is mixed with the material of flexibility to provide the

planar heating unit with flexibility. This makes the planar heating unit capable of keeping the electrode and the heating element from being damaged due to extension and contraction, and adaptable for use in such apparatuses as electrically-heated carpet and automobile seat heater that are subject to bending, extension and contraction.

[0008]

[Description of the Preferred Embodiments] The invention disclosed in claim 1 provides a planar heating unit comprising an electrode and a heating element having a self-temperature regulating function and connected with the electrode, wherein at least a part of the electrode and the heating element is mixed with a material of flexibility, thereby enabling it adaptable for use in any heating/warming apparatus requiring flexibility such as an electrically-heated carpet.

[0009] The invention disclosed in claim 2 is a planar heating unit, in which one of an urethane resin and a polyester resin is used specifically as the material of flexibility. Any of these materials can provide the heating unit with a sufficient degree of flexibility.

[0010] The invention disclosed in claim 3 is a planar heating unit, wherein the electrode and the heating element are disposed on at least a part of a substrate having flexibility in order to improve a physical strength while maintaining the flexibility. The heating unit can thus become adaptable for use in any heating/warming apparatus requiring physical strength and durability beside the flexibility such as an automobile seat heater and the like.

[0011] The invention disclosed in claim 4 is the planar heating unit, wherein any of fabric and leather is used as a material of the substrate.

[0012] The invention disclosed in any of claim 5 and claim 6 is the planar

heating unit, wherein at least a part of the electrode and the heating element has a configuration of conductive film. This structure allows use of a printing method to form any of the electrode and the heating element into a film form on the substrate having flexibility, thereby improving manufacturing efficiency in the mass-production, and reducing the manufacturing cost.

[0013] The invention disclosed in any of claim 7 and claim 8 is the planar heating unit, wherein film thicknesses of the electrode and the heating element are made to their optimum values. This ensures both flexibility and reliability of the planar heating unit.

[0014] The invention disclosed in claim 9 is a planar heating unit so constructed that at least a part of the electrode and the conductor film has flexibility, and thereby it only exhibits flexibility in an area where the flexibility is required.

[0015] The invention disclosed in claim 10 is a heating apparatus such as an electrically-heated carpet and a warmer as a specific product equipped with the planar heating unit of this invention.

[0016]

[Exemplary Embodiment] Description is provided of an exemplary embodiment of the present invention with reference to the accompanying drawings.

[0017] Embodiment 1: Fig. 1 is an external view depicting a structure of a planar heating unit according to embodiment 1 of this invention. Fig. 2 is a cross sectional view of the planar heating unit taken along the line A – A in Fig. 1. In Fig. 1, reference marks 1a and 1b denote electrodes composing a matching pair, and heating element 2 is formed in electrical connection with these electrodes 1a and 1b. Here, any of electrodes 1a, 1b and heating

element 2 is composed of a material mixed with a flexible material to make the planar heating unit flexible. The electric power to electrodes 1a and 1b is supplied from power supply 3 through connecting wires 5a and 5b. Electrodes 1a and 1b and connecting wires 7a and 7b are connected via connectors 4a and 4b, each comprised of a rivet and an eyelet terminal.

[0018] The heating unit of this embodiment 1 operates in a manner which is described hereinafter. As shown in Fig. 2, heating element 2 having the self-temperature regulating function is connected electrically to electrodes 1a and 1b. When power supply 3 having a DC supply source such as a battery impresses a positive potential on electrode 1a and a negative potential on electrode 1b, an electric current I flows from electrode 1a toward electrode 1b through heating element 2 to generate heat in heating element 2. A temperature of heating element 2 rises when energized, but its resistance increases rapidly when it reaches a given temperature, thereby regulating its own temperature to a constant level.

[0019] The planar heating unit of suitable flexibility was obtained when any of an urethane resin and a polyester resin was used specifically as the material having flexibility.

[0020] Although not shown in any of the drawings, the above planar heating unit may be formed integrally with a flexible substrate on a part of or the entire surface thereof.

[0021] By forming the electrodes and the heating element integrally with the substrate having flexibility in this manner, there is achieved the planar heating unit with improvement in the physical strength while maintaining the flexibility by virtue of the physical strength provided by the substrate, thereby making it adaptable for a variety of applications.

[0022] Materials suitable as the substrate having flexibility include clothes

woven with the warp and weft, pile fabrics such as velveteen, corduroy, towel and the like pile velvet, general fabrics such as plain fabric, rib-stitched fabric, purl-stitched fabric, tucked fabric, brocade, piled fabric, lace fabric, single-Denbigh fabric, single-vandyked fabric, double-Denbigh fabric and single-vandyked fabric, unwoven fabric made of a base cloth willowed with cotton by needle-punching, artificial leather, synthetic leather, rubber, and so forth.

[0023] In addition, certain portions of the substrate may be structurally hollowed in order to further improve the flexibility and to alleviate the stiffness.

[0024] Moreover, any of the electrodes and the heating element is formed with a conductive film producible by the printing method, which achieves improvement of manufacturing efficiency in the mass-production and reduces the manufacturing cost.

[0025] In this instance, a material of the electrodes suitable for the printing method is any a silver paste, copper paste, and the like.

[0026] According to the experiment conducted, it was found that the conductive films of the electrodes can provide excellent flexibility, stable electrical property and high productivity when formed into a thickness of a range between 5 and 40μm, although the optimum thickness may vary depending the material used for the electrodes.

[0027] Likewise, it was found that the heating element can provide uniformity in temperature of the entire heating area as well as excellent flexibility by forming it into a thickness of a range between10 and 100μm.

[0028] Although the printing method was used in the above embodiment to configure the wiring pattern of the electrodes and the heating element, it is conceivable to alter this ordinary printing method so that the conductive

material is mixed with an UV hardening agent and fixed by ultraviolet rays instead of fixing it in a drying process. It is also possible to form a similar wiring pattern with an electrostatic coating process, as another alternative method, by using the conductive material in a pulverized form.

[0029] It is possible to limit the use of the material having flexibility only for a part of electrodes 1a, 1b and heating elements 2, where the flexibility is needed, or the area subject to flexing for example, so as to form it with the flexibility given only in the minimum required area.

[0030] In the present embodiment, power supply 3 was shown as to be the DC power source. However, the like advantageous effect can be attained with power supply 3 made of an AC supply when heating element 2 is composed of a material having a self-temperature regulating characteristic suitable for the AC power supply, as needless to mention.

[0031] It is conceivable that the planar heating units of this invention can be adapted for use in electric heating/warming apparatuses represented by an electrically heated carpet shown in Fig. 3, for example. In Fig. 3, reference mark 8 denotes a heating surface provided internally with heating element 9. Reference mark 10 denotes a control unit for controlling heating element 9 with the capability of adjusting it to the desired temperature. Reference mark 11 denotes a power supply cord for supplying electric power.

[0032] By virtue of the above structure, the user is able to sit on heating surface 8 to get warm. The planar heating unit is also adaptable for use in warmers such as a rice cooker shown in Fig. 4. Reference mark 12 denotes a heating element for heating object 13 to be kept warm. Reference mark 14 denotes an outer enclosure, which confines object 13 to maintain thermal insulation while protecting it from the external environment. Reference mark 15 denotes a power supply cord for supplying electric power. The

warmer can keep object 13 warm by virtue of the above structure. Other specific examples of products include such electric heating/warming apparatuses as electrically-heated lap robe, electric blanket, electric foot warmer, floor heater, tatami-mat heater, electrically-heated mattress, electrically-heated cushion, heated bathroom mat, heated jacket, heated gloves, heated toilet seat with cover and automobile seat heater, and such heating apparatuses as food warmer.

[0033]

[Advantage of the Invention] According to the present invention, as described above, there is provided the planar heating unit with flexibility since it comprises the electrode and the heating element having the self-temperature regulating function and electrically connected with the electrode, wherein a part of the electrode and the heating element is mixed with the material of flexibility, thereby making it adaptable for use in such apparatuses as floor heater, electrically-heated carpet, tatami-mat heater and automobile seat heater that are subject to bending, extension and contraction.

[0034] In addition, the present invention can easily and stably provide the planar heating unit of superior flexibility at low cost by use of the printing method since the electrode and the heating element are formed into thin flexible films.

[Brief Description of the Drawings]

[Fig. 1] An external view showing a planar heating unit according to exemplary embodiment 1 of the present invention.

[Fig. 2] A cross sectional view showing the planar heating unit according to the exemplary embodiment 1 of the present invention.

[Fig. 3] An external view showing an electric heating/ warming apparatus as an example of product equipped with the planar heating unit of this

invention.

[Fig. 4] An external view showing an electric warmer as another example of product equipped with the planar heating unit of this invention.

[Fig. 5] An external view showing a structure of a planar heating unit of the prior art.

[Description of the Reference Marks]

1a, 1b Electrode

2 Heating element